

operandi, Brennand, with his water-motion actinometer, drew up, by an ample series of observations extended over several years, the Table B given in NATURE (January 8, 1891, p. 237). The numbers in this table are ratios, and they may be all multiplied by any number without any real alteration in the table. The unit of chemical action originally started with was the blackness produced by 100 grains of a candle burnt at the unit of distance; and this is the unit which underlies Table B. Brennand early found, as Roscoe found, that the sun has always the same effect at the same altitude in a perfectly clear sky. Hence, in all the later observations the unit was recovered from the sun.

Thus, to take a series of observations, with the water-motion actinometer, with strips of an unknown (but uniform) paper: first, a strip is placed in the instrument, the sun alone being admitted by the vertical slit, and the sliding shutter is run up; we thus get a gradually tinted slip beside the gauge marked in seconds. The altitude of the sun is noted; suppose it 30° ; the number in Table B for this altitude is 0.1070, *i.e.* the number of seconds which produces unit darkening by sun alone at this altitude is $\frac{1}{0.107}$ seconds = $9\frac{1}{2}$ seconds. Then on the

sun strip a mark is made opposite the $9\frac{1}{2}$ seconds graduation on the gauge; this is the unit blackness for the paper, and any subsequent strip exposed is "read" by marking the point on it which has the same blackness.

This method of recovering the unit is not sufficient to determine, for instance, whether the sky in England on a certain morning was really clear, *i.e.* as truly clear as the Dacca cold-weather sky. To determine this particular point, Brennand lately in England burnt 100 grains of a candle (as near as he could get) similar in composition to his Dacca candle, and the result shows conclusively, by the exact accord of several observations lately made near Taunton with corresponding old observations at Dacca, that in this case the two candles must have produced equal effects. But it is obvious that the candle could only be trusted by these results. The experiments made with the candle were not made to recover the Dacca unit, but to test the candle. The exact agreement in the several results raises the very strongest presumption that the Taunton candle was equal to the Dacca candle. It is, however, possible that the Taunton sky varied for the several observations in exact ratio with a variation in the Taunton candle; and it can only be said that Brennand's observations on this particular point, so far as they go, support Roscoe's result that the chemical action of the sun is the same at the same altitude in a perfectly clear sky, always and everywhere.

When the chemical action of the sky (or of some portion of it) on a piece of flat paper is observed, what is measured is the integral of the resolved effects of each sky element. Thus if, as in Roscoe's experiments, the piece of sensitized paper is exposed horizontally, and the effect of the whole sky (the sun being stopped off) is taken, we have the total effect of a ring of the sky distant θ from the zenith to be multiplied by $\cos \theta$, and then the effect of all such rings from the zenith to the horizon to be summed. This view of the resultant action suggested to Brennand the more original branch of his investigations. He was early led to suspect that the chemical action of the sky varied in different parts of it. He devised an instrument, which he calls the mitrailleuse actinometer, by which he was enabled to prove that the chemical action of the sky is a minimum in the great circle distant 90° from the sun; for an altitude α of the sun this minimum he calls i_a . Brennand then further proves that the chemical action (at the same time) at any other point of the sky distant θ from the sun is then $i_a \csc \theta$.

Having established these important laws, Brennand is able, by mathematical process, having i_a given him, to calculate the total effect of any defined portion of the sky on a plane of sensitized paper exposed at any given angle. He was thus enabled to compare Roscoe's readings of total diffused daylight on paper exposed horizontally with his own Dacca readings on paper exposed perpendicularly to the direction of the sun.

These investigations led Brennand to a theoretic value for the duration of twilight, and to the devising a new instrument, the "octant actinometer," by which the fundamental constant i_a can be observed directly.

This "octant" actinometer observes one-eighth of the heavens, cut out by three planes at right angles to each other, placed so that the line OS, the intersection of two of the planes, passes through the sun. Owing to the cloudy skies of Taunton, Bren-

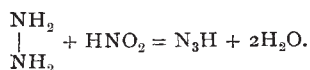
nand (who experiments only with a clear sky) had been able very imperfectly to test this instrument at the time his paper was read to the Royal Society. He has since found that this "octant" may be turned in any way round OS (above the horizon, of course) without altering the reading on either of the three planes of the octant. This "octant," therefore, only requires one-fourth of the visible hemisphere round the zenith to be clear, for a good observation. What is more important, it enables the observer, when the sky is clear, and the sun's altitude from 30° to 60° , to take an observation of a part of the sky entirely 30° from the horizon; so that the uncertainty arising from haze near the horizon (which could not before be allowed for) may by this capital instrument be avoided, and i_a obtained without any integrations or calculations beyond division by a number.

In the whole of these later developments, Brennand's work is entirely original. Sir Henry Roscoe, following a somewhat different course of inquiry, has made experiments on the chemical action of the sun and sky at different levels above the sea; and on the total effect during different months or seasons of the English sky with all its cloud, fog, and smoke; which last is an important practical measure of the climate in its influence on vegetation, and perhaps on human health.

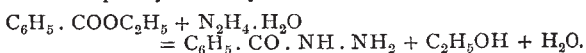
The researches of Roscoe and Brennand have thus, though overlapping at particular points, extended mainly in different directions. Brennand, in the ground covered by both, puts forward far the more accurate determinations; his table (B) given in NATURE, January 8, 1891, p. 237, professes to be of the same character and value as a table of the constants of refraction.—Brennand has had half a century's experience with the chemistry of photographic paper, and is an excellent mathematician of the old school. Moreover, the three leading actinometric instruments he has devised, the water-motion, the mitrailleuse, and the octant, show him to be possessed of much resource in devising instruments of research.

INORGANIC SYNTHESIS OF AZOIMIDE, N_3H .

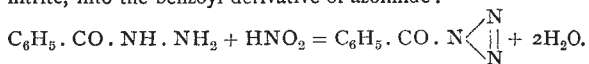
A METHOD of synthesizing this interesting compound of nitrogen and hydrogen, by means of a simple reaction involving only purely inorganic substances, has been discovered by Prof. Wislicenus, and is described by him in a communication to the current number (No. 12) of the *Berichte* of the German Chemical Society. The reactions by which azoimide has hitherto been obtained have all been of an organic nature, and more or less complicated. The mode of preparation described by its original discoverer, Prof. Curtius, in reality depends upon a very simple reaction, that of nitrous acid upon hydrazine, N_2H_4 , the other hydride of nitrogen whose preparation we also owe to Prof. Curtius,



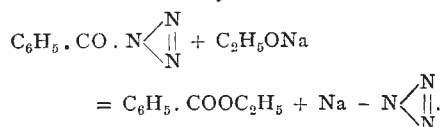
Hydrazine, however, has only yet been prepared from its organic derivatives, and moreover it has not been found practicable to actually convert free hydrazine itself by means of nitrous acid into azoimide, only certain organic derivatives being acted upon by nitrous acid with production of azoimide. The perfected mode of preparation described by Prof. Curtius at the close of last year is very briefly as follows. Benzoyl hydrazine, $\text{C}_6\text{H}_5 \cdot \text{CO} \cdot \text{NH} \cdot \text{NH}_2$, is first formed by reacting with ethyl benzoate upon hydrazine hydrate:



The benzoyl hydrazine is then converted by means of nitrous acid, obtained from a mixture of glacial acetic acid and sodium nitrite, into the benzoyl derivative of azoimide:



From benzoyl azoimide the sodium salt of azoimide is next formed by treatment with sodium ethylate:—

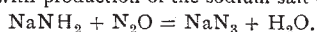


Free azoimide is finally obtained by distilling the crystals of the sodium salt with dilute sulphuric acid, and repeatedly re-distilling over fused calcium chloride the hydrated liquid which first passes over.

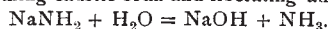
As an alternative method which has some advantages as regards facility of manipulation, Prof. Curtius employs the hippuryl derivative of hydrazine instead of the benzoyl compound. The product of the action of nitrous acid upon this compound is a substance which can be readily isolated in crystals, and if these crystals are dissolved in dilute caustic soda, the solution at once yields azoimide upon distillation with dilute sulphuric acid.

Before describing the inorganic synthesis of Prof. Wislicenus, it may be mentioned that a still simpler organic synthesis of azoimide from the long known diazobenzene imide, $C_6H_5N_3$, has been achieved by Drs. Noelting and Grandmougin. Although diazobenzene imide itself is too stable a substance to yield azoimide directly by simple saponification with soda, these chemists found that its dinitro derivative yielded directly to the attack of an alcoholic solution of potash, the potassium salt of azoimide being formed, which of course gave free azoimide upon distillation with dilute sulphuric acid.

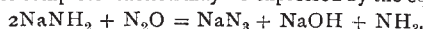
The inorganic synthesis of azoimide now achieved by Prof. Wislicenus depends upon the interaction of ammonia gas and nitrous oxide in the presence of heated metallic sodium. Ammonia and nitrous oxide do not act directly upon each other, not even when a mixture of the two gases is passed over caustic bases—soda-lime for instance. But they react readily in presence of metallic sodium. The explanation of this lies in the fact that the sodium amide discovered by Gay Lussac and Thenard is first formed, and this compound reacts with the nitrous oxide with production of the sodium salt of azoimide:—



The water produced at the same time reacts with one-half of the sodamide, forming caustic soda and liberating ammonia gas:—



Hence the complete reaction may be expressed by the equation—



As the sodium salt is less explosive than most of the other salts of azoimide, requiring a higher temperature and not being sensitive to percussion, the experiment is not dangerous if proper care is exercised, and even if local explosions do occur they have not yet been observed to shatter the glass tube. Unfortunately glass is somewhat strongly attacked during the reaction, but if iron tubes are employed the reaction is not so completely under control.

In actually conducting the experiment, metallic sodium, in pieces not exceeding half a gram in weight, is placed in a series of large porcelain boats, which are then laid in a glass combustion tube, from which the air is subsequently displaced by means of a current of ammonia gas. The tube is heated carefully in a combustion furnace, when the sodium fuses and gradually passes into sodamide. When all the metal has been thus changed, the stream of ammonia is replaced by one of dry nitrous oxide. The temperature should now be lowered to between 150° and 250° , and for this purpose Prof. Wislicenus surrounds it by an iron explosion chamber, which forms a capital air-bath, the temperature of which can be regulated by observing a thermometer or thermometers inserted in it. The sodamide now slowly increases in bulk and becomes converted into the sodium salt of azoimide. As soon as ammonia ceases to be carried away in the stream of issuing nitrous oxide the reaction is completed. Upon cooling the sodium salt is found as a porous pumice-like substance, much distended by the escaping ammonia.

The sodium salt of azoimide is also formed when ammonia and nitrous oxide gases are simultaneously passed over melted sodium; the yield, however, is not so large, and there is danger of the sodium inflaming in the nitrous oxide.

The fact that the sodium compound obtained is the sodium salt of azoimide has been proved both by direct analysis (a determination of nitrogen yielding close upon the theoretical amount) and by its properties. The product of the reaction on being removed from the combustion tube was thrown into water, and the filtered solution distilled with dilute sulphuric acid. The distillate possessed the intolerable odour characteristic of azoimide, and behaved exactly like a solution of that substance in water. It gave precipitates with nitrates of silver, mercurous mercury and lead, which when separated and dried were found to possess all the properties of the silver, mercury, and lead salts

of azoimide respectively. The fact that these salts were those of azoimide was indeed sufficiently apparent from their violently explosive nature, and the characteristic flames which were produced during their explosion. Moreover, gold dust was rapidly dissolved with production of the red solution described by Prof. Curtius.

A quantity of the silver salt was subjected to analysis, and was found to contain 71.7 per cent. of silver, the amount calculated for AgN_3 , being 71.8.

Instead of sodium, either potassium or zinc may be employed. Potassium answers almost as well as sodium, forming first an amide when heated in a current of ammonia, which is subsequently converted by nitrous oxide into the potassium salt of azoimide. Zinc likewise behaves in a similar manner, but the yield of the zinc salt of azoimide, ZnN_3 , is not so good as in the cases of sodium and potassium. To a greater or less extent, therefore, it would appear that metallic amides when heated in a current of nitrous oxide are generally converted into salts of azoimide. The alkali metals, however, appear to be best suited for practical use.

A. E. TUTTON.

THE REPORTED VOLCANIC ERUPTION AT GREAT SANGIR.

ACCORDING to a Reuter's telegram from Sydney, despatched on July 17, the vessel *Catterthun*, belonging to the Eastern and Australasian Steamship Company, which had arrived at Sydney from China, brought a report of a terrible disaster in the vicinity of the Philippine Islands. She called on her voyage at one of the chief ports of the island of Timor, where rumours had been received according to which the island of Sangir, situated between Celebes and Mindanao, had been destroyed by a volcanic eruption. The whole population, numbering 12,000, was reported to have perished. The captain of the *Catterthun* stated that on the voyage his vessel passed through some miles of volcanic *débris*.

We may not for some time receive further details as to the real extent of the disaster reported by the captain of the *Catterthun*, but in the meantime the following account, by Mr. Sydney J. Hickson, author of "A Naturalist in North Celebes," of the island and of the history of its volcanic energy—which appeared in the *Times* of Tuesday—will be read with interest:—

Sangir, or "Great Sangir," as it is more frequently called by the natives of the Archipelago, is the largest of a chain of volcanic islands that connects the northern peninsula of Celebes with the southern point of the island of Mindanao. The islands, rising abruptly from the floor of the very deep Celebes sea—a depth of over 2,000 fathoms was found by Her Majesty's ship *Challenger* quite close to Great Sangir—are very mountainous and covered by dense tropical forests.

The islands Ruang and Siauwa are both little more than volcanoes standing in the sea, but Sangir is a large island 25 miles long by about 15 miles broad, with undulating hills and valleys occupying its southern half, and the great Awu volcano and its slopes the greater part of its northern half.

When I visited the islands in November, 1885, the Ruang and the Awu were quiet, but the Siauwa was sending out dense volumes of smoke that varied little in intensity from day to day.

From the accounts I received from the natives and from the records of the islands in the Dutch books of travel, it seems that the Siauwa volcano has never been very violently active, but both the Ruang and the Awu have a history full of most terrible and heart-rending episodes. Of the Ruang I need not say much. The last serious eruption occurred in 1871, when at least 400 persons lost their lives either by the sudden rise of the sea water that accompanied the eruption, or by the showers of stones and ash. Of the Awu volcano we find recorded in Valentijn's "Oud en Nieuw Oost Indien" that a most terrible eruption occurred which lasted from the 10th to the 16th of December, 1711. Sjamsialam and his son, the Princess Lorolabo and her daughter Sarabanong, and over 2000 people of the kingdom of Kandahar were killed. On March 2, 1856, there was another fearful eruption, which lasted until March 17, and destroyed nearly 3000 human lives. The streams of boiling water and of steam which poured down the mountain slopes rather than the flow of lava caused the enormous mortality of this second eruption. After the eruption of 1711 it seems that a large lake of water was formed in the crater, and a certain privileged class of Sangirese were allowed by the gods to visit this lake every three or four months to test the water with their rice. If